Japanese Published Unexamined Patent Application (A) No. 05-341132; published December 24, 1993; Application Filing No. 04-153790, filed June 12, 1992; Inventor(s): Akira Tanaka et al.; Assignee: Fujitsu Corporation; Title of Invention: Surface-Light Source Units

---

SURFACE-LIGHT SOURCE UNITS

CLAIM(S)

1) A surface-light source unit comprising: a photo-conductive plate 11 for guiding the incident light from its side surfaces 11a and 11b and emitting it from the surface 11c; light sources 12a and 12 positioned to oppose to said side surfaces 11a and 11b and radiating the light into said photo-conductive plate 11; light permeable light control plates, 21, 31, 41, 51, positioned on the surface 11c of said photo-conductive plate 11; said surface-light source being characterized in that said light control plates, 21, 31, 41, 51, are integrated with light refraction sections, 23, 43, that direct the light emitted from said surface 11c after passing through said photo-conductive plate 11 in the direction virtually perpendicular to the front surface of said surface-light source and with light diffusion sections, 22, 33, that diffuse the light passing through the light control plate body.

2) A surface-light source unit, wherein the light diffusion section of Claim 1 is roughened surface 22 which is located on the opposite side to the other surface, where said refraction section is installed, of the light control plate.

3) A surface-light source unit, wherein the diffusion section of Claim 1 is

structured by dispersing the diffusing particles 33 made of inorganic or organic compound having different refractivity from that of said light control plate.

DETAILED DESCRIPTION OF THE INVENTION

(Field of Industrial Application)

(0001)

(Field of Industrial Application)

The present invention pertains to a surface-light source unit, particularly to that used as a back light of a liquid display device.

(0002)

To enhance visibility of a display device, a light source (back light) is generally installed in the back side of the display surface of the display device. The light source for the back light of the display device that needs to uniformly illuminate the liquid display device is required to have a surface-light source unit.

(0003)

Fig. 8 shows one example of the application of a surface-light source unit. In the figure, 1 indicates a liquid crystal panel, which has the display pattern formed by orientating the liquid crystal into the prescribed pattern in the display surface 2. In the figure, 3 indicates the surface-light source unit, which is positioned behind the liquid crystal panel 1 so that its light source surface 4 opposes to the liquid crystal panel 1 to illuminate the entire back surface of the liquid crystal panel 1.

(0004)

The surface-light source unit of this type needs to have a high brightness level and the entire light source surface needs to be uniformly bright.

(0005)

(Prior Art)

Fig. 9 shows the prior art surface-light source unit. In the figure, 11 indicates a photo-conductive plate of the surface-light source unit 10, which is made of light-permeable resin such as an acrylic resin. Holders 13a and 13b are positioned to oppose to the side surfaces 11a and 11b to condense and direct the light radiated from cold-cathode tubes 12a and 12b and cold-cathode tubes 12a and 12b toward the side surfaces 11a and 11b.

(0006)

On the back surface 11d of the photo-conductive plate 11, reflection plate 14 with high light reflectivity is installed, and on the surface 11c of the photo-conductive plate 11, lenticular plate 15 with multiple prism units, 15a, 15b, ..., is installed to cover the entire surface 11c. On the surface opposite to the surface of the lenticular plate with multiple prism units, 15a, 15b, ..., opaque light-diffusion plate 16 which is a light source surface of the surface-light source unit is installed.

(0007)

The operation of said surface-light source unit is explained below. Once the cold-cathode tubes 12a and 12b radiate the light, the light is condensed and directed toward the side surfaces 11a and 11b from the holders 13a and 13b and goes in the

photo-conductive plate 11 from its side surfaces 11a and 11b. The light that has come into the photo-conductive plate 11 is emitted to the outside of the photo-conductive plate 11 from its surface 11c due to presence of the reflection plate 14 on the back surface 11d.

(0008)

On the surface 11c of the photo-conductive plate 11, lenticular plate 15 is installed, and multiple prism units, 15a, 15b, ..., refract the light emitted from the surface 11c and direct it in the perpendicular direction to the front surface of the surface-light source unit 10, so the light emitted from the surface 11c enters multiple prism units, 15a, 15b, ..., and enters the light-diffusion plate 16 in the perpendicular direction.

(0009)

The light-diffusion plate 9 is opaque in color, diffuses the incident light from the lenticular plate 15, and corrects the unevenness of the incident light before emitting it. Accordingly, the light emitted from the light-diffusion plate 16 is evenly bright on the entire light-diffusion plate 16.

(0010)

(Problems of the Prior Art to Be Addressed)

With the prior art surface-light source unit, however, multiple prism units, 15a, 15b, ..., function as the light refraction section that directs the light in the perpendicular direction to the front surface of the surface-light source unit, and the

light-diffusion plate 16 functions as a light diffusion section to provide uniformity to the brightness of the back light, so these sections are structured as separate members.

(0011)

Therefore, the prior art surface-light source unit contains many components, which makes the surface-light source unit thick and inefficient in manufacturing.

(0012)

The present invention was produced to solve the aforementioned problems, and attempts to present a surface-light source unit free from those problems by integrating the light refraction section and the light diffusion section into one unit.

(0013)

(Means to Solve the Problems)

To solve the aforementioned problems, the invention cited in Claim 1 claims a surface-light source unit comprising: a photo-conductive plate that guides the light coming in from the side surfaces, to be emitted from the top surface; a light source positioned to oppose to the side surfaces of the photo-conductive plate and takes in the light from the side surfaces of said photo-conductive plate; a light-permeable control plate installed on the surface of said photo-conductive plate; and said light control plate has a structure, wherein are integrated the light refraction section that refracts the light, which is being emitted from the surface of the photo-conductive plate after passing through the photo-conductive plate, in the perpendicular

direction to the front surface of said surface-light source unit and the light diffusion section that diffuses the light that has permeated the light control plate.

(0014)

The invention cited in Claim 2 claims a structure wherein the light diffusion section of Claim 1 is a roughened surface on the side opposite to the surface where said refraction section is made on said light control plate.

(0015)

The invention cited in Claim 3 claims that the diffusion section of Claim 1 is prepared by dispersing into the body of said light control plate the inorganic or organic diffusing particles having different reflectivity from that of said light control plate body.

(0016)

(Operation)

Said structure, wherein the light refraction section and the light diffusion section of Claim 1 are integrated, as cited in Claim 1, does not require a light-diffusion plate.

(0017)

According to said structure of Claim 2, the light emitted from said surface-light source unit is refracted and diffused at a time when it passes through said roughened surface. Thus, said roughened surface constitutes said light diffusion section, so merely by processing the surface opposite to said light refraction section

of the prior art lenticular plate, said light refraction section and said light diffusion section having said roughened surface are integrally formed into one unit.

(0018)

According to said structure of Claim 3, the light being emitted from said surface-light source unit is repetitively refracted and diffused by said multiple diffusion particles dispersed on the light control plate body. The light control plate body containing said light diffusion particles can be constructed by forming said light diffusion section first and by forming the light refraction section on the sheet material containing said light diffusion particles. Thus, said light refraction section and said light diffusion section made of light control plate body containing said diffusion particles are integrally formed into one unit.

(0019)

(Embodiment Examples)

Fig. 1 shows a sectional view of the surface-light source unit as one embodiment example of the present invention. In the figure, the same symbols are supplied to the same components as those indicated in Fig. 9, and the explanation is omitted.

(0020)

The surface-light source unit 20 of the present invention presents uniformly bright illumination via the light control plate 21 by condensing the light emitted from the cold-cathode tubes 12a and 12b equivalent to said light source by the

holders 13a and 13b, taking the light in from the side surfaces of the photo-conductive plate 11, and by efficiently emitting it from the surface 11c of the photoconductive plate 11 by means of the reflection plate 14.

(0021)

The light control plate 21 has, on its bottom surface, a prism unit group 23, which is composed of multiple linearly arranged prism units, 23a, 23b, equivalent to the light refraction section, and has the roughened surface 22 equivalent to the light diffusion section on the opposite surface (top surface) to the prism unit group 23 of the light control plate; the prism unit group 23 is thus installed to oppose to the top surface 11c of the photoconductive plate 11.

(0022)

Therefore, the light emitted from the surface 11c of the photo-conductive plate 11 enters the prism unit group 23, is refracted in the direction perpendicular to the front surface of the surface-light source unit 20, transmits through the light control plate 21 to the roughened surface 22. The roughened surface 22 refracts and diffuses the light passing through it. By this, the light emitted from the roughened surface 22 becomes the uniformly bright light on the roughened surface 22.

(0023)

The ligh control plate 21 is made of light-permeable resin, such as polycarbonate, and the prism unit group 23, like the prior art lenticular plate, is formed by reduction rolling by a roller having on its side surface the section having

multiple annular convex units that corresponds to the shape of the prescribed prism unit group.

(0024)

Accordingly, the light control plate 21 as the embodiment example of the present invention can be manufactured merely by roughening the surface opposite to the prism unit group 2 after the prior art lenticular plate is manufactured, so the facility used for the prior art processing can be used as is.

(0025)

Thus, the prism unit group 23 and the roughened surface 22 can be integrally formed easily, and the light diffusion plate that was needed for the prior art is no longer necessary, which allows to make the surface-light source thinner and reduce the number of components, contributing to the productivity.

(0026)

Fig. 2 shows a sectional view of the surface-light source unit as the second embodiment example of the present invention. In the figure, the same symbols are supplied to the same components as those in Fig. 1 and Fig. 8, and the explanation is omitted.

(0027)

In the figure, 31 indicates the light control plate of the surface-light source unit in this embodiment example, wherein the prism unit group 23 is installed in contact with the surface 11c of the photo-conductive plate 11. The body of the light

control plate 31 constitutes the light diffusion section for its containing the diffusion particles 33 with a light diffusion effect, such as silica, barium sulfate, or titanium oxide particles.

(0028)

Therefore, the light emitted from the surface 11c of the photo-conductive plate 11 is refracted by the prism unit group 23 of the light control plate 31 and is directed virtually in the perpendicular direction to the front surface of the surface-light source unit 30. Subsequently, the light is, in the process of passing through the inside of the light control plate body, repetitively diffused by the diffusion particles 33 contained in the plate body, so when the light is emitted from the light control plate 31, the entire surface-light source surface 32 has a uniform brightness level. By this, the surface-light source unit 30 works as a back light having a uniformly bright light.

(0029)

The light control plate 31 can be easily manufactured by reduction rolling a light-permeable resin sheet, such as that of polycarbonete, containing diffusion particles 33 by a roller for forming said prism unit group 23, and it can be manufactured by the same prior art process by diffusing the diffusion particles into said resin material before it is formed.

(0030)

Thus, by merely modifying the light control plate, the surface-light source

unit in this embodiment example of the present invention can be manufactured by exactly the same process as that of the prior art. Like said surface-light source unit in the first embodiment example, said surface-light source can be made thinner, which contributes to the productivity.

(0031)

Fig. 3 shows a sectional view of the key components of the surface-light source as the third embodiment example of the present invention. In the figure, the same symbols are supplied to the same components as those in Fig. 1, Fig. 2, and Fig. 8, and the explanation is omitted.

(0032)

In the figure, 41 indicates the light control plate of surface-light source unit of this embodiment example. It has, on its bottom surface, Fresnel lens 43, which contains multiple lined up lens units, 43a, 43b, ..., equivalent to the light refraction section and has roughened surface 22 on the top surface opposing to the Fresnel 43, like the optical control plate 21 in the first embodiment example; thus, the lens unit is installed to oppose to the surface 11c of the photo-conductive plate 11.

(0033)

With the photo-conductive plate 11 using its side surfaces as the light-incident surfaces, the emission angle of the light emitted from the surface 11c of the photo-conductive plate 11 is roughly determined by the reflection angle of the reflection plate 14. When the light is emitted from the neighborhood of the side surface 11a of

the photo-conductive plate 11, the emission angle is smaller relative to the case when it is emitted from neighborhood of the central section of the photo-conductive plate 11.

(0034)

On the other hand, the curvature of each of the multiple lens units, 43a, 43b, ..., is determined so as to efficiently refract the incident light from the surface 11c of the photo-conductive plate 11 in the prescribed direction to the incident angle.

(0035)

Therefore, the light emitted from the surface 11c of the photo-conductive plate 11 goes into the Fresnel lens 43 and is efficiently refracted by each of the lens units, 43a, 43b, ..., into the direction perpendicular to the front surface of the surface-light source unit 20. Subsequently, the light, as in the first embodiment example, transmits through the light control plate 41, goes into the roughened surface 22, is diffused by the roughened surface 22, and becomes highly bright uniform light on the entire roughened surface 22.

(0036)

The light control plate of the surface-light source unit 41 of this embodiment example can also be manufactured by reduction rolling using the aforementioned roller, and the Fresnel lens 43 and the roughened surface 22 can be easily integrated into one unit.

(0037)

Fig. 4 shows a sectional view of the key components of the surface-light source unit as the fourth embodiment example of the present invention. In the figure, the same symbols are supplied to the same components as those in Fig. 1 - Fig. 3 and Fig. 8, and the explanation is omitted.

(0038)

In the figure, 51 indicates the light control plate of the surface-light source unit of this embodiment example. As shown in the figure, the Fresnel lens 43 wherein multiple lens units, 43a, 43b, ..., are formed, is installed to oppose to the light emission surface 11c of the photo-conductive plate 11, as in the third embodiment example. The body of the light control plate 31 contains diffusion particles 33, as in said second embodiment example.

(0039)

Therefore, the light emitted from the light emission surface 11c of the photo-conductive plate 11 is refracted at the Fresnel lens 43 of the light control plate 51, is directed in the direction perpendicular to the front surface of the surface-light source unit 50, is repetitively diffused by the diffusion particles 33 when passing through the light control plate 51, and becomes the uniformly bright back light on the entire surface of the light source surface 52.

(0040)

The light control plate 51 also can be easily formed by reduction-rolling a

light-permeable resin sheet material, such as polycarbonate material, by the aforementioned roller, by which the surface-light source unit can be made thinner and the productivity can be raised.

(0041)

As explained above, since the light control plates, 21, 31, 41, 51, of the surface-light source unit are integrated with the light refraction section constructed by the prism unit group 23 or Fresnel lens 43 and with the light diffusion section of the roughened surface 22 or the light control plate containing the diffusion particles 33, the surface-light source unit can be made thinner, and the productivity can be raised.

(0043)

Fig. 5 shows a sectional view of the surface-light source unit as the fifth embodiment example.

(0044)

In the figure, the surface 11c of the photo-conductive plate 11 and the roughened surface 22 oppose to each other in the light control plate 22. Therefore, the light emitted from the surface 11c of the photo-conductive plate 11 is first diffused at the roughened surface 22, refracted by the prism unit group 23, and is directed in the direction perpendicular to the front surface of the surface-light source unit 60. Thus, the light control plate 21 produces the same effect as that in the first embodiment example even if the roughened surface 22 is made to oppose to

the surface of the photo-conductive plate 11.

(0045)

On the back surface 11d of the photo-conductive plate 11 of this embodiment example, the reflection material 61 coated with a white paint is installed so that the occupancy rate of the reflection material 61 per unit dimension increases toward the center from the side surfaces 11a and 11b. Therefore, the reflectivity of the back surface 11d of the photo-conductive plate 11 per unit dimension is lowest in the neighborhood of the side surfaces 11a and 11b and highest in the neighborhood of the center.

(0046)

With a general photo-conductive plate using the opposing side surfaces for the light incident surfaces, the light concentration is highest in the neighborhood of the side surfaces near the light source, such as the cold-cathode tube and is lowest in the neighborhood of the center far from the light source, so the light emitted from the surface of the photo-conductive plate is darkest in the center.

(0047)

With the surface-light source unit 60 of this embodiment example, the reflectivity is highest in the neighborhood of the center by the presence of the reflection material 61, so the light emitted from the surface 11c of the photo-conductive plate 11 is uniformly bright, and by combining the reflection material with the light control plate 21, even more uniform illumination can be produced. In

this embodiment example, the reflectivity is changed by the reflection material 61, but the means of changing the reflectivity is not limited to this reflection material, but the reflectivity can be changed by changing the roughness level.

(0048)

Fig. 6 shows a sectional view of the surface-light source unit as the sixth embodiment example of the present invention.

(0049)

In the figure, 71 indicates the photo-conductive plate, and the photo-conductive plate 71 is thickest at the sides 11a and 11b and is thinnest in the center, so the surface 11c is formed in convex shape.

(0050)

As mentioned above, in the photo-conductive plate using the opposing side surfaces as the incident surface, the incident angle of the light coming into the surface of the photo-conductive plate from the inside of the photo-conductive plate is larger in the center than in the neighborhood of the side surfaces. Since the total light reflection tends to be generated in the center of the photo-conductive plate, the photo-conductive plate cannot be made thinner.

(0051)

With the photo-conductive plate 71 of this embodiment example, the surface 11c is formed into a convex shape to make the central section thinnest and to minimize the incident angle in the central section of the photo-conductive plate 71;

by this the total reflection can be prevented. Accordingly, the photo-conductive plate 71 can be made thinner and the surface-light source unit 70 can be made lighter in weight. In addition, by combining this photo-conductive plate 71 with the light control plate 21, the surface-light source unit can be further made thinner.

(0052)

Fig. 7 shows a front sectional view of the surface-light source unit as the seventh embodiment example of the present invention.

(0053)

In the figure, 80 indicates the surface-light source unit, which is one side light source using cold-cathode tube 12b. In the figure, 82 indicates the light source reflection plate, which reflects the light coming in from the side surface 11b opposing to the photo-conductive plate 81.

(0054)

The photo-conductive plate 81 is a photo-conductive plate for an one-side light source, which prevents the total reflection of the light at the location far from the cold cathode tube 12b and transmits the incident light from the light source installed on one side to the entire surface of the photo-conductive plate 8, so the surface 11c is formed into a convex shape so that the section near the light source reflection plate 82 can be thinner than the central section.

(0055)

Accordingly, the photo-conductive plate 81 of this embodiment example can

efficiently and uniformly emit the incident light from the cold-cathode tube 12b on one side, from the surface 11c of the photo-conductive plate 8, and by combining this photo-conductive plate 81 with the light control plate 21, the uniformly bright surface-light source unit can be manufactured at low cost.

(0056)

In said embodiment example, the reflection material 61 is used only for the photo-conductive plate 11, but it can be combined with photo-conductive plates 71 and 81. Each of the photo-conductive plates 71 and 81 has a V-shaped convex in sectional view, but the shape can also be a u-shaped convex.

(0057)

In the above example, the prism units, 23a, 23b, ..., share the same shape and are positioned at a regular pitch, but they can be formed in different shapes and positioned at an irregular pitch.

(0058)

(Advantage)

As explained above, by the invention claimed in Claim 1, by integrally forming the light-refraction section and the light diffusion section in one unit, the number of components can be reduced, so the surface-light source unit can be made thinner and the productivity can be raised.

(0059)

By the invention claimed in Claim 2, merely by roughening the surface of the

prior art lenticular plate, the light refraction section and the light diffusion section can be integrally structured, so the light control plate integrated with the light refraction section and with the light diffusion section can be manufactured merely by adding the roughening step to the prior art manufacturing process.

(0060)

By the invention claimed in Claim 2, the light control plate can be manufactured by the same process as the prior art lenticular plate manufacturing process only by changing the prior art lenticular plate material with the material containing the diffusion particles.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 shows a sectional view of the surface-light source unit as the first embodiment example of the present invention.

Fig. 2 shows a sectional view of the surface-light source unit as the second embodiment example of the present invention.

Fig. 3 shows a sectional view of the surface-light source unit as the third embodiment example of the present invention.

Fig. 4 shows a sectional view of the surface-light source unit as the fourth embodiment example of the present invention.

Fig. 5 shows a sectional view of the surface-light source unit as the fifth embodiment example of the present invention.

Fig. 6 shows a sectional view of the surface-light source unit as the sixth

embodiment example of the present invention.

Fig. 7 shows a sectional view of the surface-light source unit as the seventh embodiment example of the present invention.

Fig. 8 illustrates one example of the application of the surface-light source unit.

Fig. 9 shows a sectional view of the prior art surface-light source.

11. Photo-conductive plate

11a, 11b. Side surface

11c. Surface

21, 31, 41, 51. Light control plate

22. Roughened surface

23. Prism unit group

23a, 23b. Prism unit

33. Diffusion particle

43. Fresnel lens

43a, 43b. Lens unit

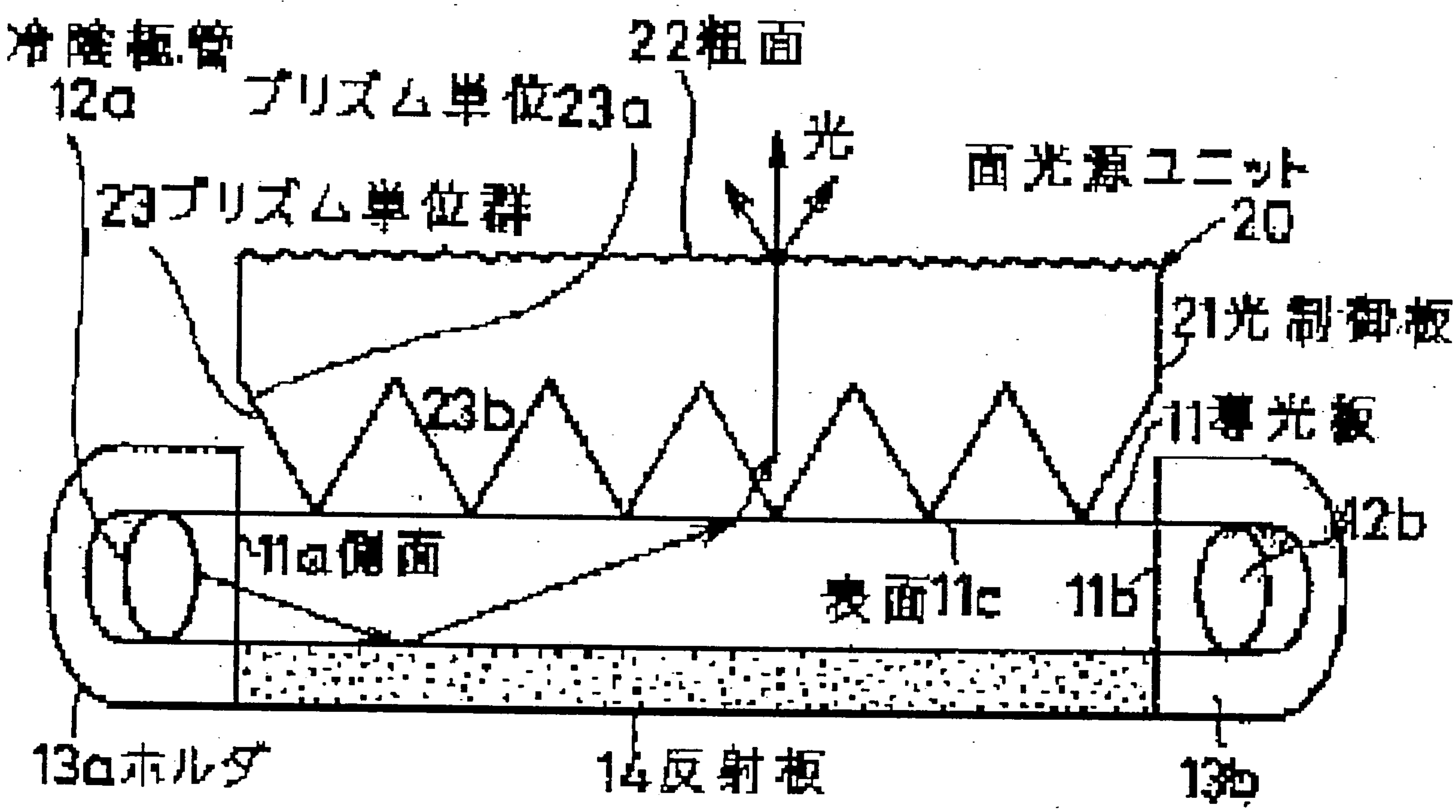
JP5341132 Biblio Page 1 [redacted]

SURFACE LIGHT SOURCE UNIT

Patent Number:	JP5341132
Publication date:	1993-12-24
Inventor(s):	TANAKA AKIRA; others: 01
Applicant(s)::	FUJITSU LTD; others: 01
Requested Patent:	JP5341132
Application Number:	JP19920153790 19920612
Priority Number(s):	
IPC Classification:	G02B6/00 ; G02F1/1335
EC Classification:	
Equivalents:	

Abstract

PURPOSE:To reduce the number of parts, and make a surface light source thin, and improve the productivity by forming a light refraction part and a light diffusion part integrally with each other.
CONSTITUTION:A light control plate 21 has a prism unit group 23, which consists of continuous multiple prism units 23a, 23b,..., as a light refraction part in the lower surface thereof. The other surface (top surface) of the light control plate 21 opposite to the prism unit group 23 is formed with the rough surface 22 as a light diffusion part. The prism unit group 23 is arranged opposite to the surface 11c of a light guide plate 11. The light output from the surface 11c of the light guide plate 11 therefore enters the prism unit group 23, and is refracted to the direction vertical against the front surface of a surface light source unit 20, and is transmitted to the rough surface 22 through a main body of the light control plate 21. The rough surface 22 refracts and diffuse the light passing through the rough surface 22. The light output from the rough surface 22 thereby has the even brightness over the whole of the rough surface 22.


冷陰極管
12a
プリズム単位23a
22粗面
光
面光源ユニット
23プリズム単位群
20
21光制御板
23b
11導光板
12b
11a側面
表面11c
11b
13aホルダ
14反射板
13b